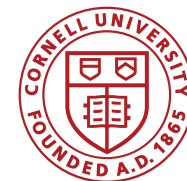


Fragile FRAC 7 Fungicides: Part II – Field performance for control of Stemphylium leaf blight in onion in New York

Christy Hoepting, CCE Cornell Vegetable Program

Empire State Producers (Virtual) Expo – Onion Critical Issues Session
January 14, 2020

Acknowledgements



Funding:

- Bayer Crop Science
- BASF
- Certis
- Ag Biome
- Other – Frank Hay projects

Grower Cooperators:

- Max Torrey, Big O, Elba
- John Dunsmoor, Oswego

CVP Technicians:

- Emma van der Heide
- Sarah Caldwell

CCE Intern:

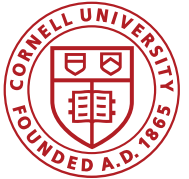
- Taran Bauer



Products: Syngenta, Summit Agro

Spray by Number for Fungicide Resistance

Number = FRAC Code



Classified for
"RESTRICTED USE"
in New York State
under 6NYCRR Part 326

ACCEPTED
VIA NOTIFICATION
LABEL NOT REVIEWED
March 5, 2020
New York State Department
of Environmental Conservation
Division of Materials Management
Pesticide Product Registration

DOC ID: 566828

FRAC #

PYDIFLUMETOXEN	GROUP 7	FUNGICIDE
FLUDIOXONIL	GROUP 12	FUNGICIDE

PULL HERE TO OPEN

Miravis[®] Prime

syngenta.

Fungicide

An ADEPIDYN™ brand fungicide

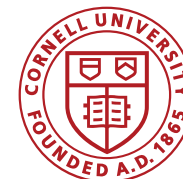
Active Ingredients:

Pydiflumetofen*	12.8%
Fludioxonil**	21.4%
Other Ingredients:	65.8%
Total:	100.0%

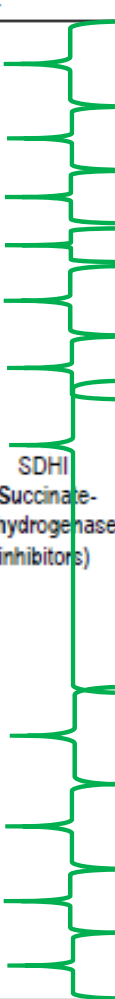
*CAS No. 1226284-64-7
**CAS No. 131341-88-1

FRAC:
Fungicide Resistance
Action Committee

SLB Onion Fungicides FRAC 7 Sub-Classes



Sub-class coding 1, 2, 3 is a “Christy thing”, not FRAC

C. respiration	C2		complex II: succinate-dehydro- genase	SDHI (Succinate- dehydrogenase inhibitors)	(6)	phenyl-benzamides	benodanil flutolanil mepronil	a b c	7	
					(5)	phenyl-oxo-ethyl thiophene amides	Kenja = sub-class 5			
					(1)	pyridine benzamides	Luna Tranquility = sub-class 1			
					(7)	furan- carboxamides	fenfuram			
					(1)	oxathiin- carboxamides	carboxin oxycarboxin			
					(8)	thiazole- carboxamides	thiifluzamide			
					(2)		Aprovia Top = sub-class 2			
							Merivon = sub-class 2			
						pyrazole-4- carboxamides	furametpyr inpyrfluxam isopyrazam			
							Fontelis = sub-class 2			
					(9)	N-cyclopropyl-N- benzyl-pyrazole- carboxamides	sedaxane isoflucypram			
					(4)	N-methoxy-(phenyl ethyl)-pyrazole- carboxamides	Miravis = sub-class 4			
					(3)	pyrazole- carboxamides	Endura/Pristine = sub-class 3			
					(10)	pyrazine- carboxamides	pyraziflumid			

Active ingredients

In same FRAC group or sub-class

Resistance known for several fungal species in field populations and lab mutants. Target site mutations in sdh e.g. H/Y (or H/L) at 257, 267, 272 or P225L, dependent on fungal species. Resistance management required.

Medium to high risk.

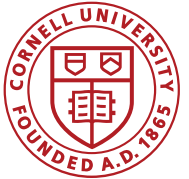
See FRAC SDHI Guidelines for resistance management.

Active ingredients

In same FRAC group or sub-class

Active ingredient within a sub-class coding a, b, c is a “Christy thing”, not FRAC

FRAC 7



Fungicide Active Ingredients

Trade Name	Active Ingredient	FRAC Code
Luna Tranquility	Fluopyram pyrimethanil	7(1) 9a
Luna Experience	Fluopyram tebuconazole	7(1) 3c
Velum Prime	Fluopyram	7(1) ★
Merivon	fluxapyroxad pyraclostrobin	7(2) 11
Miravis Prime	pydiflumetofen fludioxonil	7(4) 12
Kenja	isofetamid	7(5) ★



NOT labeled on onion.



NOT labeled on onion in New York.

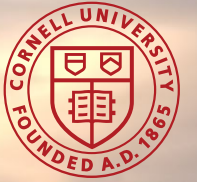


NOT labeled on onion for foliar use.

Trade Name	Active Ingredient	FRAC Code
Quadris Top	difenaconazole azoxystrobin	3b 11
Tilt	propiconazole	3a
Scala	pyrimethanil	9a
Rovral	iprodione	2
Endura	boscolid	7(3)
Pristine	boscolid pyraclostrobin	7(3) 11
Aprovia Top	benzovindiflupyr difenaconazole	7(2)c 3b
Fontelis	penthiopyrad	7(2)b ★
Sercadis	fluxapyroxad	7(2)a ★

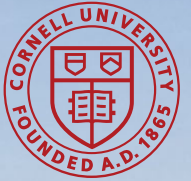
2020 Elba Early Fungicide Trial (c.v. Hamilton)

Jul 10 – Spray A (7-leaf, early bulb swell)



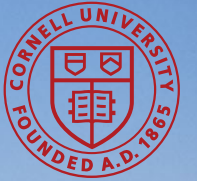
2020 Elba Early Fungicide Trial (c.v. Hamilton)

Jul 18 – Spray B (8-10 leaf, 0.5-1" bulb)



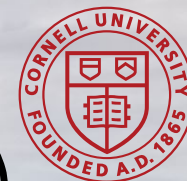
2020 Elba Product Trial (c.v Hamilton)

1st Spray Jul 24 (8-10 leaf, 1-1.5" bulb, tipburn start)



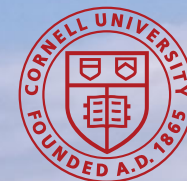
2020 Elba Early Fungicide Trial (c.v. Hamilton)

Aug 1 – Spray D (8-10 leaf, 1.5-2” bulb, 2-4” tip burn)



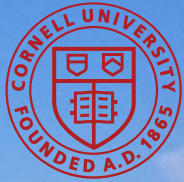
2020 Elba Early Fungicide Trial (c.v. Hamilton)

Aug 15 – Spray F (7-8 leaf, 2” bulb, 30-40% leaf dieback; 25% lodging)



2020 Elba Early Fungicide Trial (c.v. Hamilton)

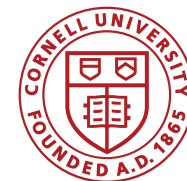
Aug 25 – 3 DAT G (5-8 leaf; 1.5-2+” bulb; 25-50% leaf dieback; 30% lodging)



Last spray (both trials): Aug 28 (50% lodging)

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)



SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Green Foliage (%/Plot) - Sep 3 6 DAT F (6 sprays)

2nd BEST

FRAC 3b + 3a:

Quadris Top 14 fl oz + Tilt 8 fl oz

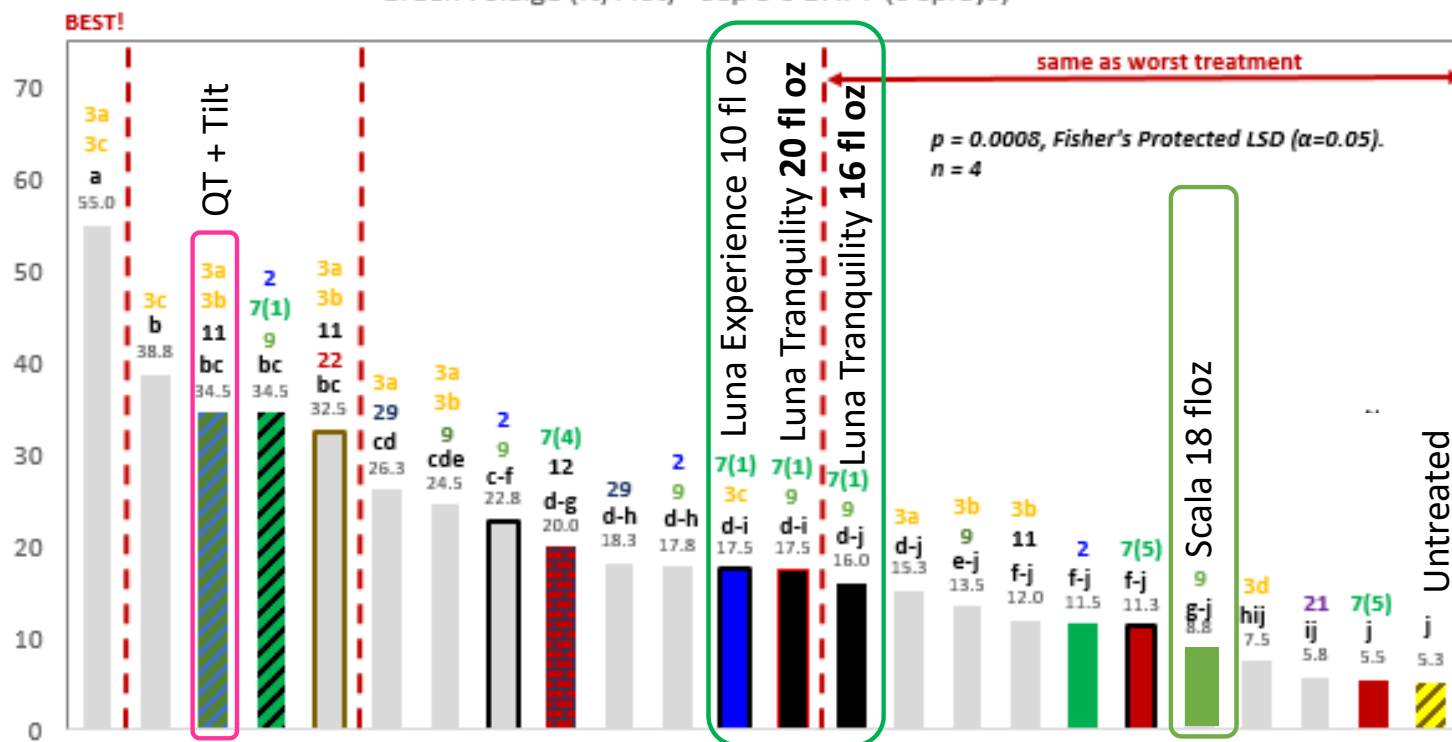
FRAC 7

Luna Tranquility 16 fl oz 7(1) + 9a

Luna Tranquility 20 fl oz 7(1) + 9a

Luna Experience 10 fl oz 7(1) + 3c

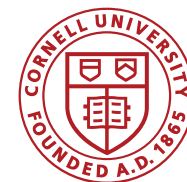
- Middle-of-the-pack/
- Significantly better than Nothing
- No difference between rates
- Significantly less green foliage than QT + Tilt



Hoepting et. al. 2020

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)



34.5%



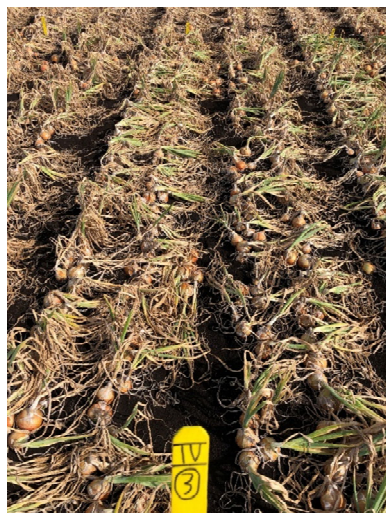
Quadris Top 14 fl oz
+ Tilt 8 fl oz
3b + 3a

16%



Luna Tranquility
16 fl oz
7(1) + 9b

17.5%



Luna Tranquility
20 fl oz
7(1) + 9b

17.5%



Luna Experience
10 fl oz
7(1) + 3c

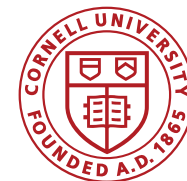
5.3%



Untreated

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)



8.8%



Scala 18 fl oz

9a

16%

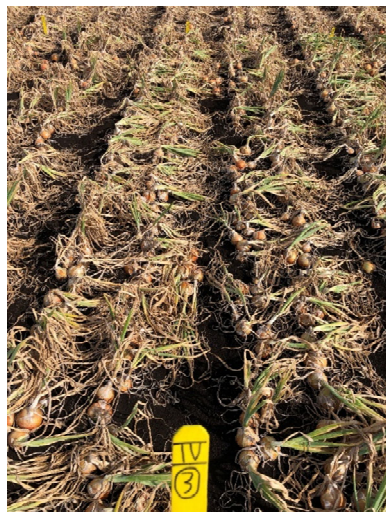


Luna Tranquility

16 fl oz

7(1) + 9b

17.5%



Luna Tranquility

20 fl oz

7(1) + 9b

17.5%



Luna Experience

10 fl oz

7(1) + 3c

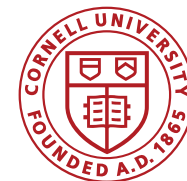
5.3%



Untreated

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)

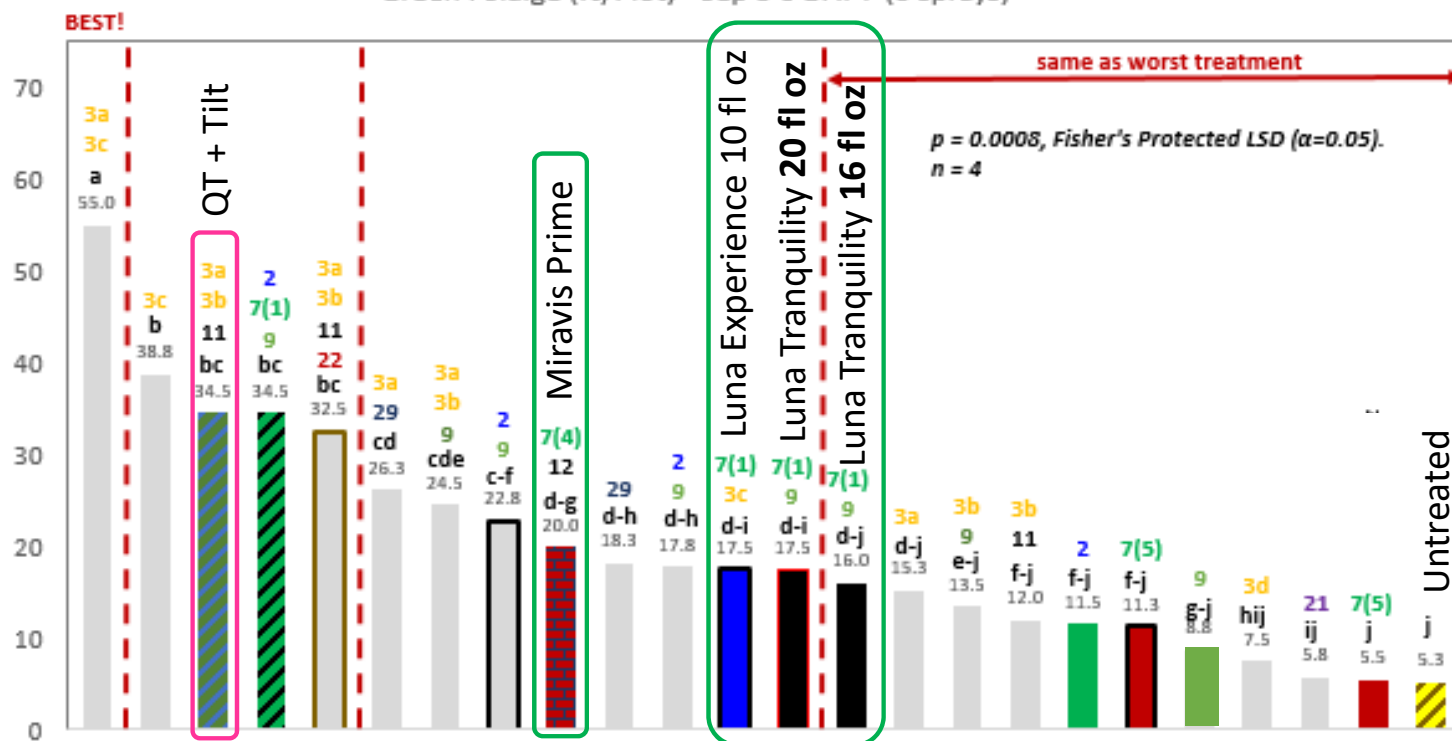


SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Green Foliage (%/Plot) - Sep 3 6 DAT F (6 sprays)

FRAC 7(4)

Miravis Prime 11.4 fl oz **7(4)** + 12

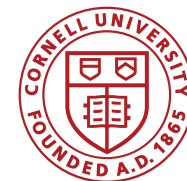
- Middle-of-the-pack/
- Significantly better than Nothing
- Significantly less green foliage than QT + Tilt
- Not significantly different than Luna products



Hoepting et. al. 2020

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)



SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Green Foliage (%/Plot) - Sep 3 6 DAT F (6 sprays)

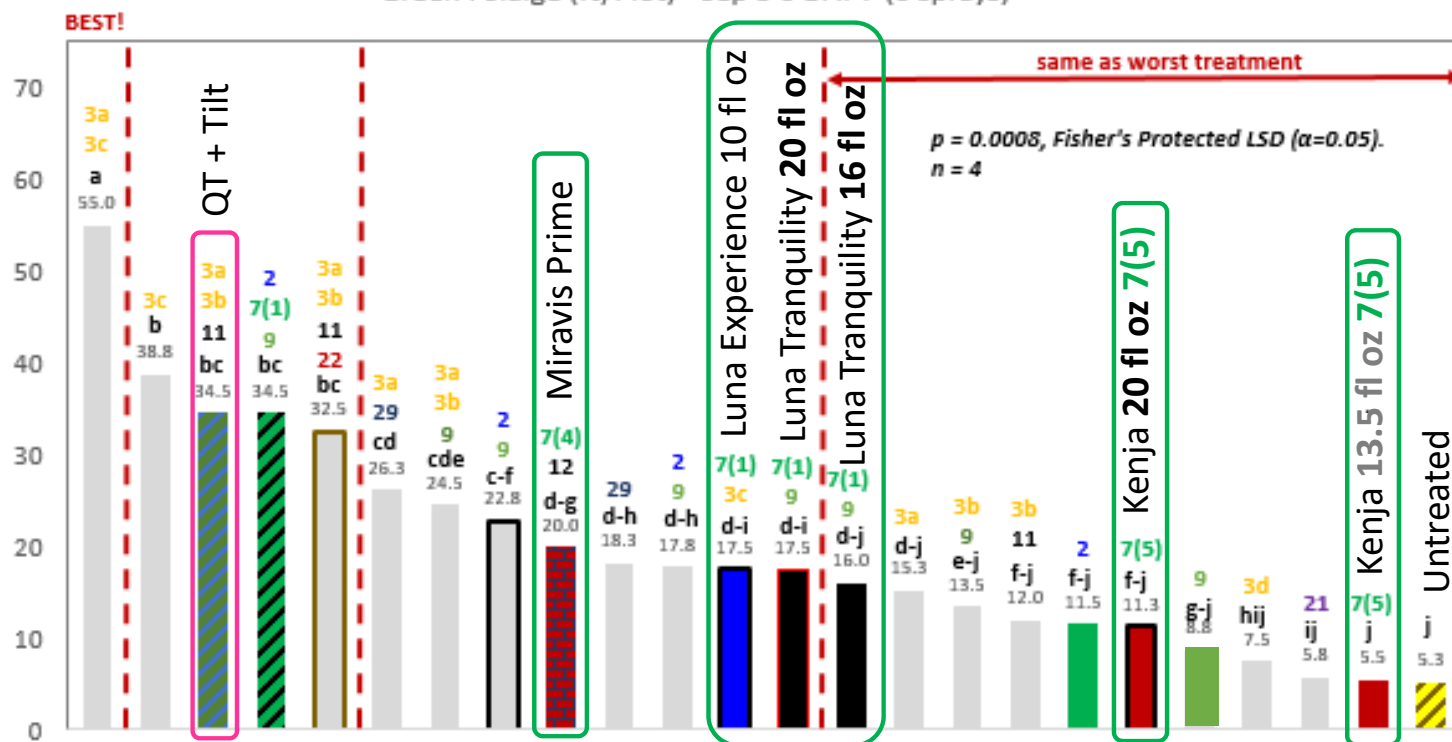
FRAC 7(5)

Kenja 13.5 fl oz 7(5)

Kenja 20 fl oz 7(5)

- Not significantly different than Untreated

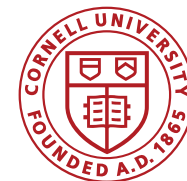
Field performance suggests cross-resistance among sub-classes of FRAC 7 1, 4 & 5.



Hoepting et. al. 2020

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)



34.5%



Quadris Top 14 fl oz
+ Tilt 8 fl oz
3b + 3a

20%



Miravis Prime
11.4 fl oz
7(4) + 12

11.3%



Kenja
20 fl oz
7(5)

5.5%



Kenja
13.5 fl oz
7(5)

5.3%



Untreated

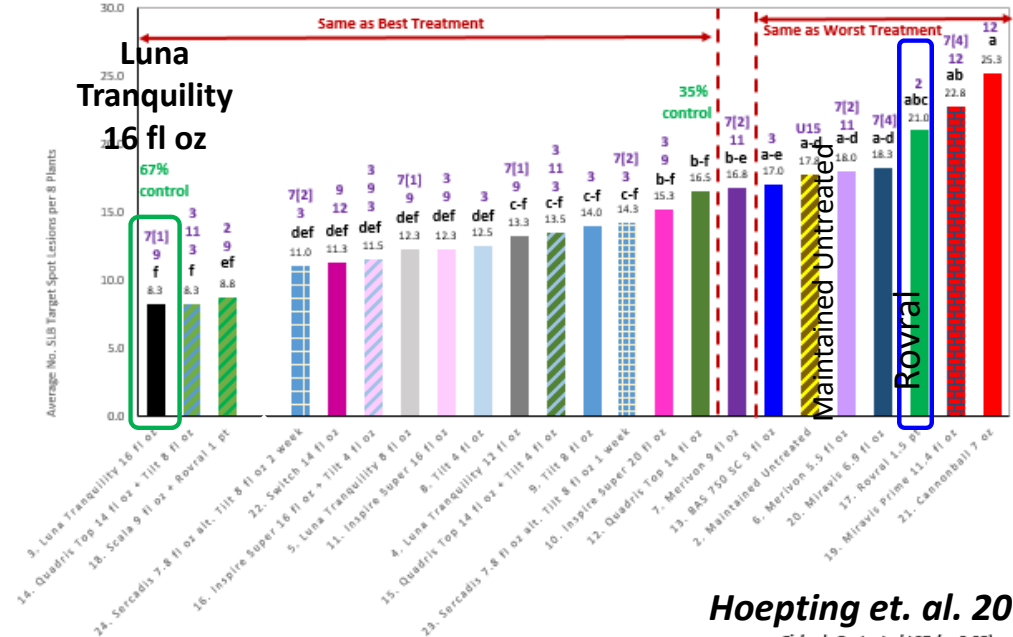
FRAC 7(1)

(healthy foliage, but lots of SLB)

(healthy foliage lipping, few SLB spots)

Total No. SLB Target Spot Lesions/8 plants

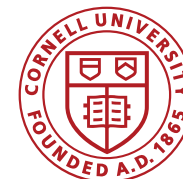
Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
No. SLB Target Spot Lesions per 8 Plants/Plot, Sep 10-11



Fisher's Protected LSD ($\alpha=0.05$)

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)



SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Green Foliage (%/Plot) - Sep 3 6 DAT F (6 sprays)

FRAC 7(1) + 9a

Luna Tranquility 16 fl oz

FRAC 2

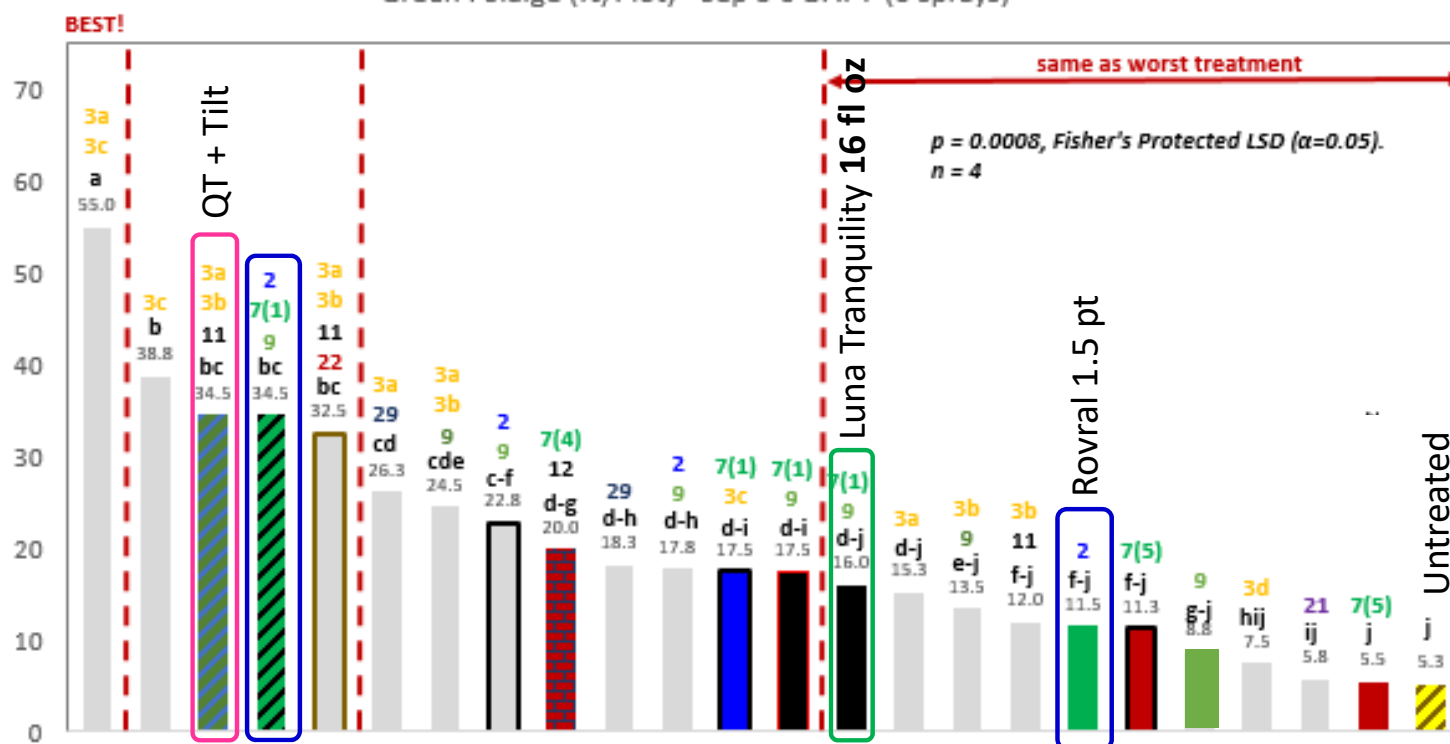
Rovral 1.5 pt

FRAC 7(1) + 9a + 2

Rovral 1 pt +

Luna Tranquility 16 fl oz

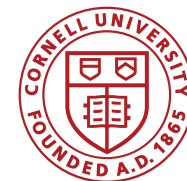
- Significantly better than either alone
- As good as QT + Tilt



Hoepting et. al. 2020

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)



34.5%



Quadris Top 14 fl oz
+ Tilt 8 fl oz

3b + 3a

34.5%



Luna Tranquility

16 fl oz

+ Rovral 1 pt

7(1) + 9b + 2

16%



Luna Tranquility

16 fl oz

7(1) + 9b

11.5%



Rovral 1.5 pt

2

5.3%

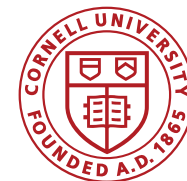


Untreated

Same results in Early fungicide trial, Elba 2020

2020 Elba Fungicide Early Trial

% Green Foliage Sep 25 DAT H (8 sprays)



SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
% Green Foliage/plot - Sep 25, 5 DAT H

FRAC 7(1) + 9a

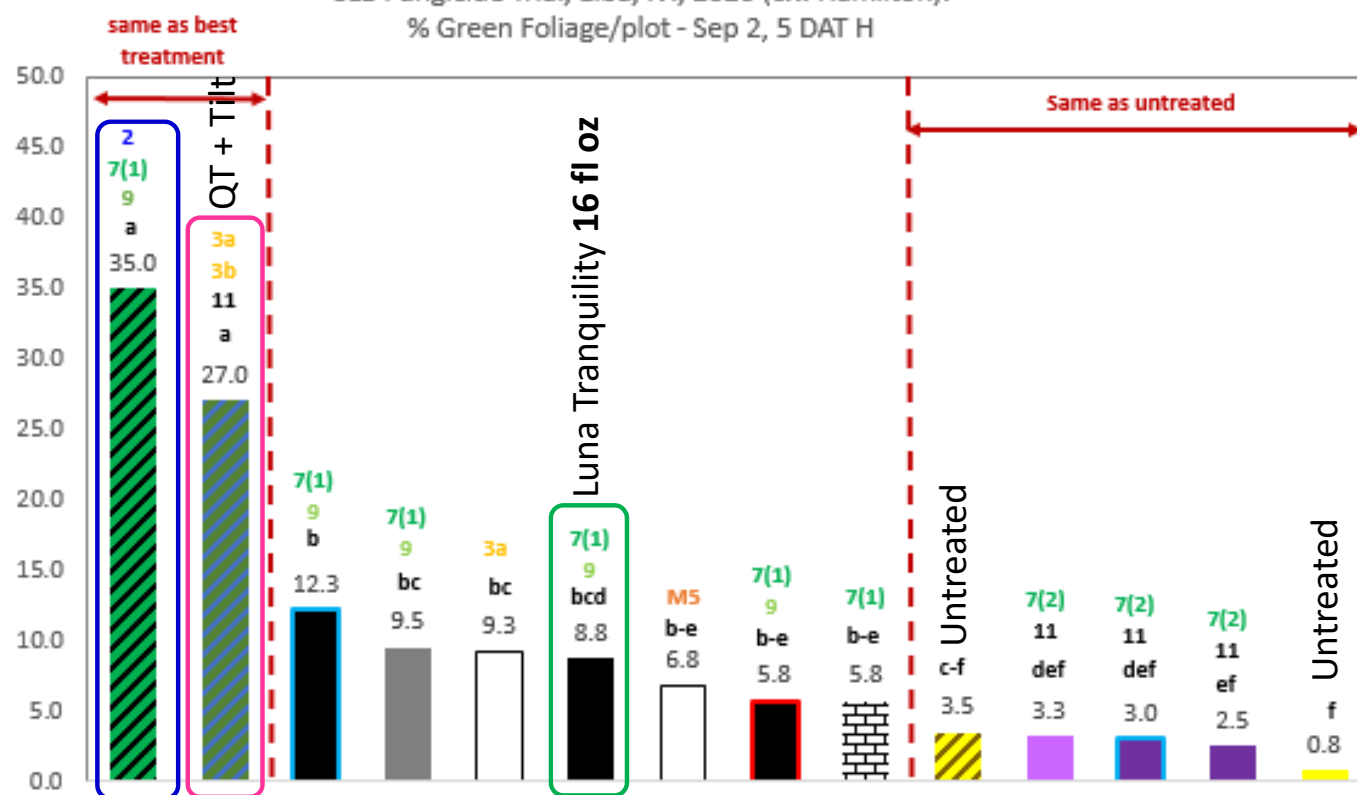
Luna Tranquility 16 fl oz

FRAC 7(1) + 9a + 2

Rovral 1 pt +

Luna Tranquility 16 fl oz

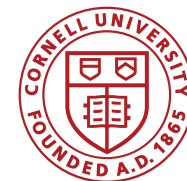
- Significantly better than either alone
- As good as QT + Tilt



Hoepting et. al. 2020

2020 Elba Fungicide Early Trial

% Green Foliage Aug 25 - 3 DAT G (7 sprays)



63%



Quadris Top 14 fl oz
+ Tile 8 fl oz
3b + 3a

63%



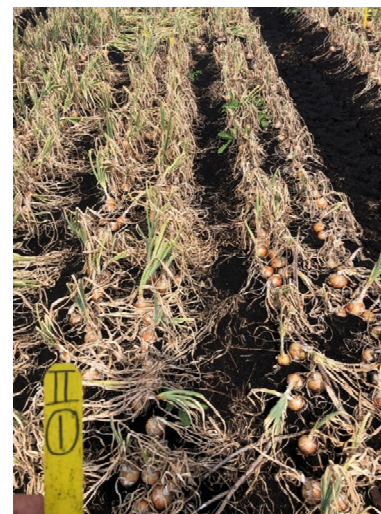
Luna Tranquility
16 fl oz
+ Rovral 1 pt
7(1) + 9b + 2

33%



Luna Tranquility
16 fl oz
7(1) + 9b

15%



Untreated
(thrips controlled)

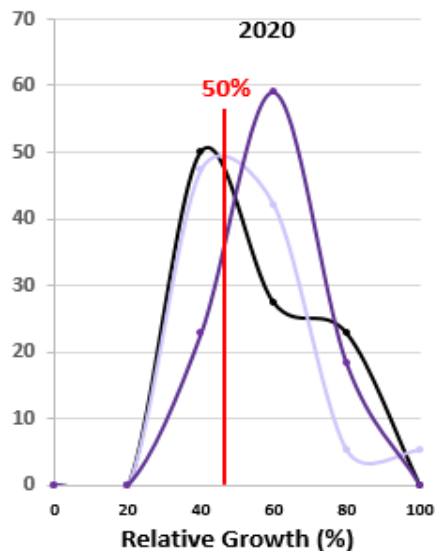
3.5%



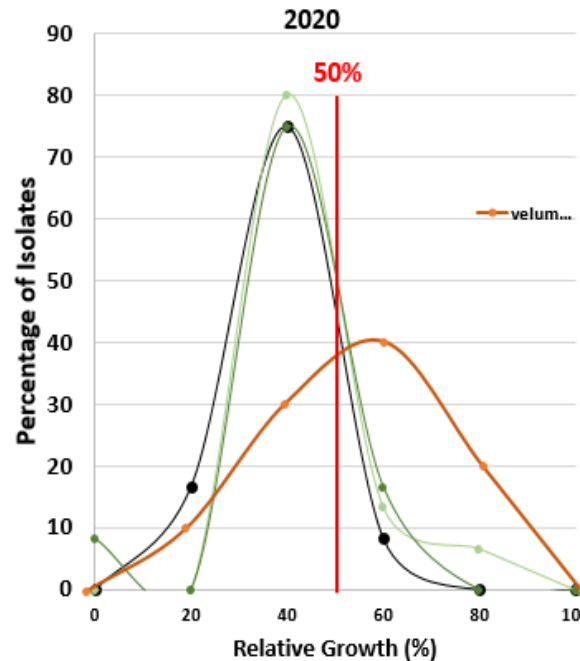
Untreated
(no insecticides)

2020 Elba Fungicide Early Trial

Luna Tranquility vs. Merivon Relative Growth (Katrin Ayer)



Merivon 5.5 & 9 fl oz
7(2) + 11



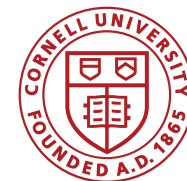
Luna Tranquility 12 & 16 fl oz
7(1) + 9
Velum Prime - 7(1)

- SLB isolates more resistant to Merivon than Luna Tranquility
- No difference between rates for either
- SLB isolates are more sensitive to FRAC 7(1) alone than 7(1) + 9a.

sensitive resistant

2020 Elba Fungicide Early Trial

% Green Foliage Sep 2 5 DAT H (8 sprays)



FRAC 7(1) + 9a Luna Tranquility

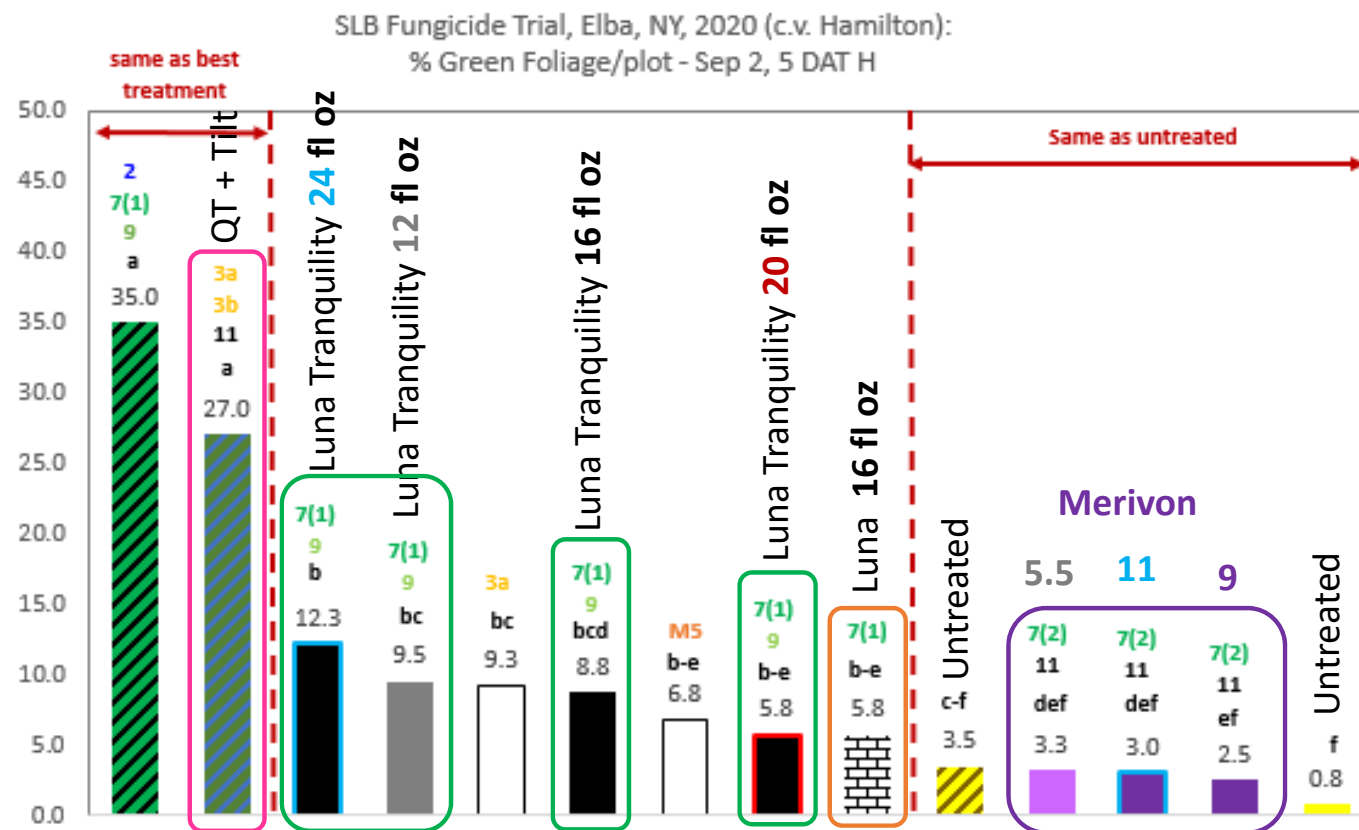
- No rate relationship
- Significantly less green foliage than QT + Tilt

FRAC 7(1) Luna

FRAC 7(2) + 11

Merivon

- No rate relationship
- No different than untreated

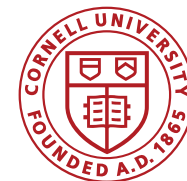


Results suggest that increasing rate of Luna Tranquility and Merivon do not help

Hoepting et. al. 2020

2020 Elba Fungicide Early Trial

No. SLB Target Spots/Plant Aug 6 - 5 DAT D (4 sprays)



FRAC 7(1) + 9a

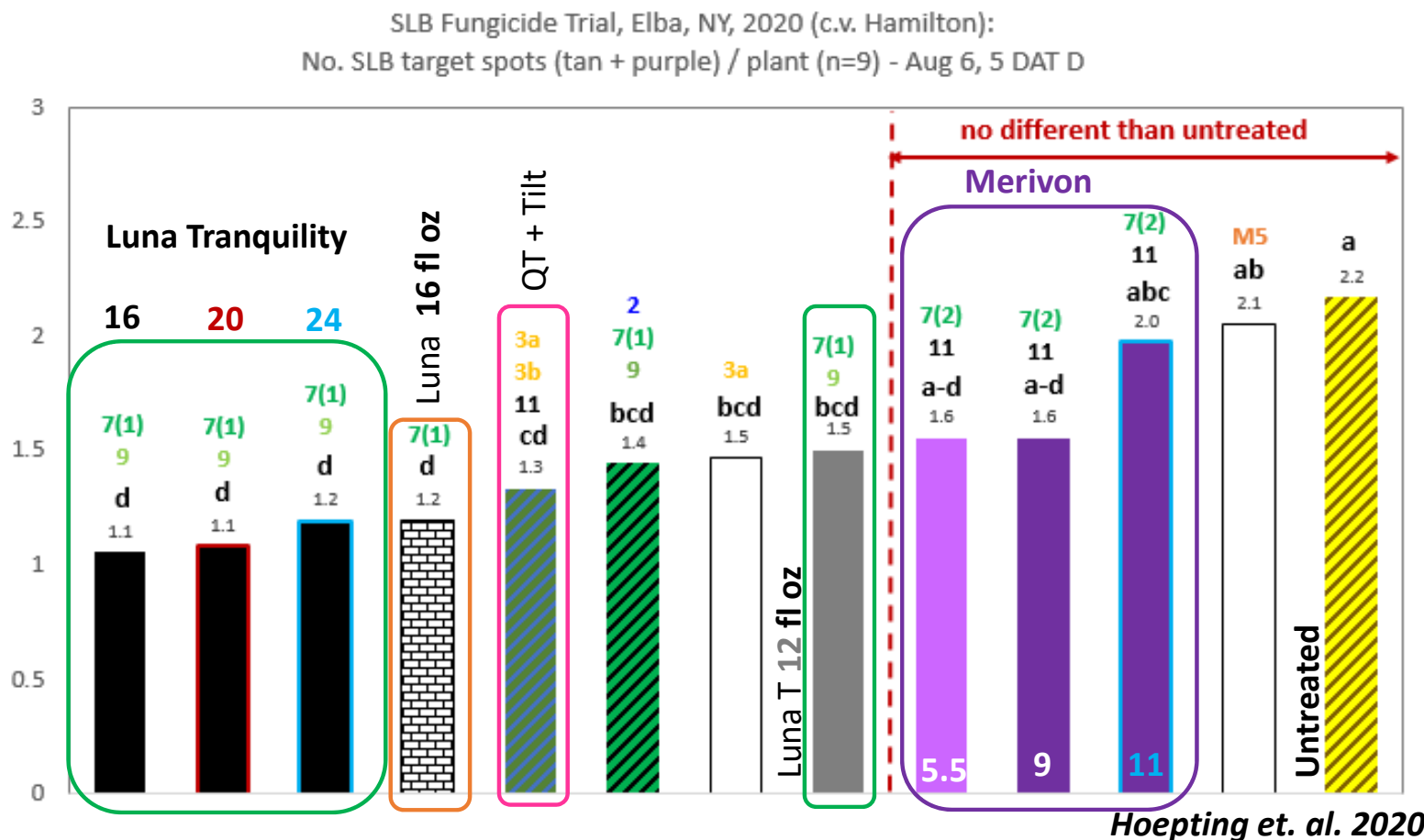
Luna Tranquility

- No rate relationship between 16, 20 & 24 fl oz & Luna 16 fl oz alone.
- No different than QT + Tilt
- 12 fl oz a few more target spots

FRAC 7(2) + 11

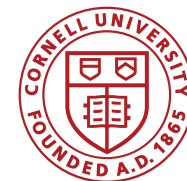
Merivon

- No rate relationship
- No different than untreated



2020 Elba Fungicide Product Trial

No. SLB Target Spots/Plant Aug 25 - 5 DAT E (5 sprays)

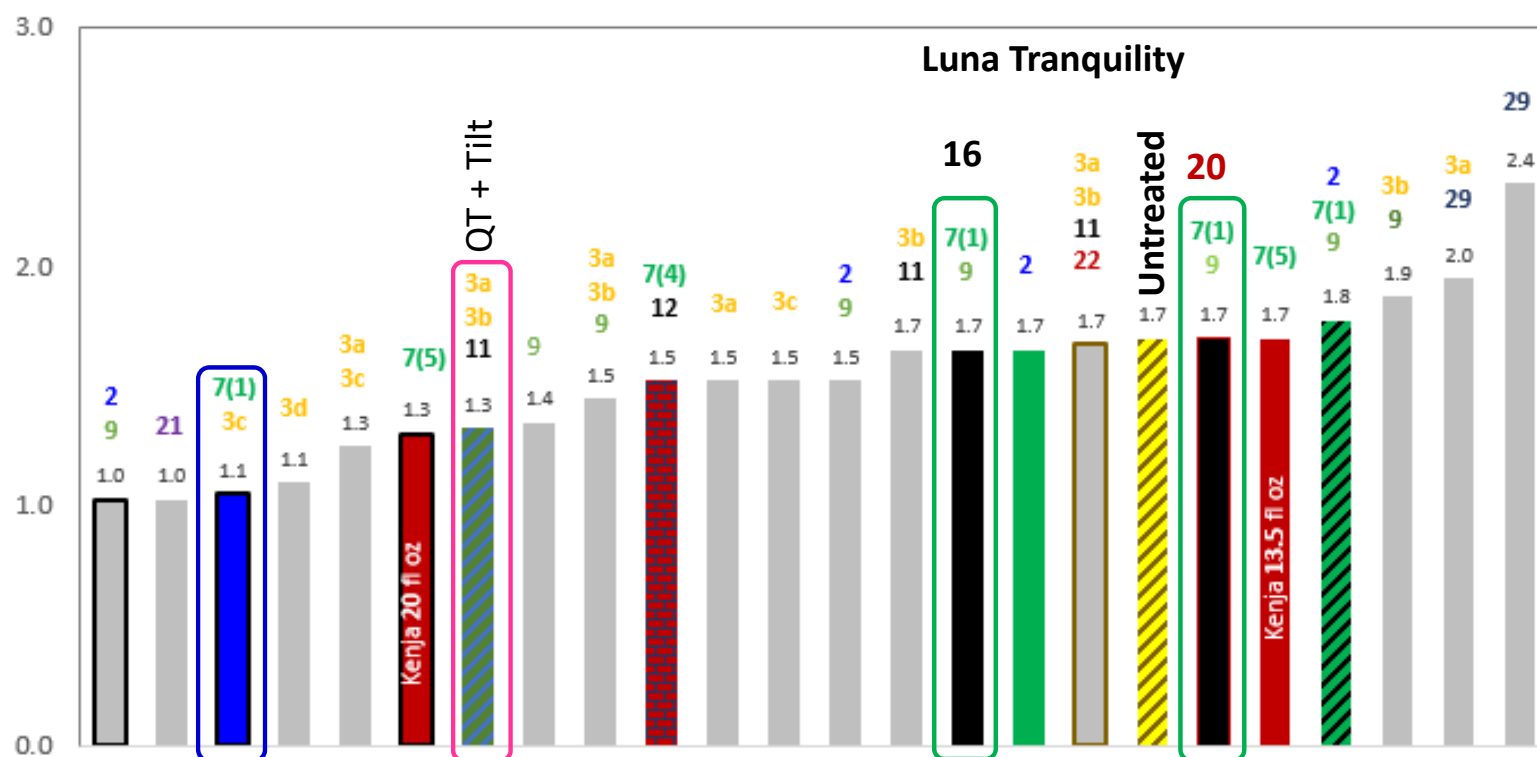


SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Total no. tan and purple SLB target lesions/plant (lesions on IYSV excluded) - Aug 26, 5 DAT E

FRAC 7(1) + 9a

Luna Tranquility

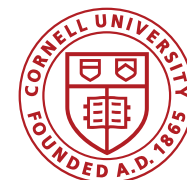
- No rate relationship between 16 & 20.
- No different than untreated.
- Luna Experience (7(1) + 3c) had fewer target spots



Hoepting et. al. 2020

2020 Elba Fungicide Product Trial

No. SLB Target Spots/Plant Aug 25 - 5 DAT E (5 sprays)



SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Total no. tan and purple SLB target lesions/plant (lesions on IYSV excluded) - Aug 26, 5 DAT E

Luna Tranquility 16 fl oz

7(1) + 9a

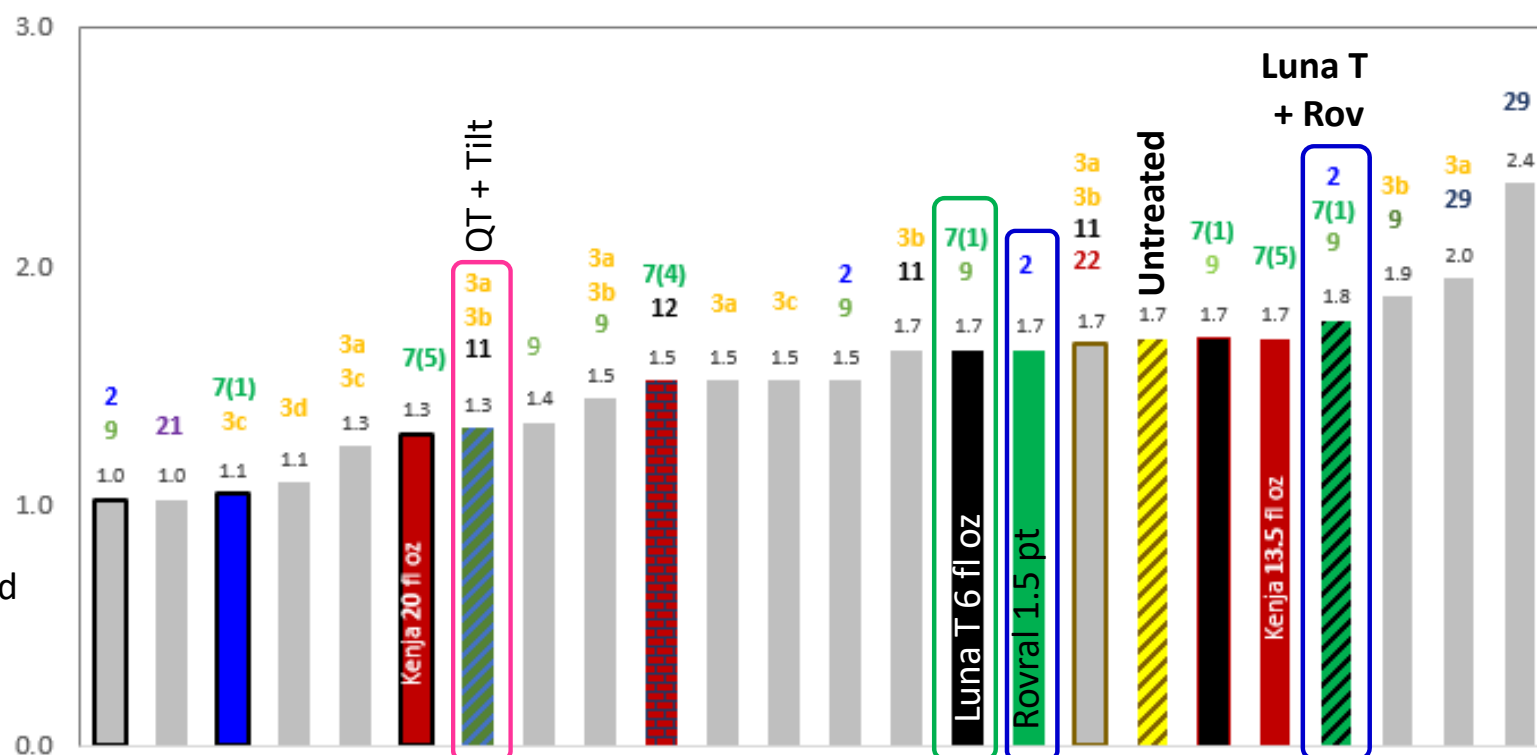
Rovral 1.5 pt 2

Luna Tranquility 16 fl oz

7(1) + 9a

+ Rovral 1 pt 2

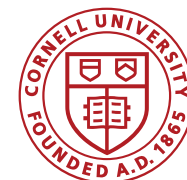
Not different than untreated



Hoepting et. al. 2020

2020 Elba Fungicide Product Trial

No. SLB Target Spots/Plant Aug 25 - 5 DAT E (5 sprays)



SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Total no. tan and purple SLB target lesions/plant (lesions on IYSV excluded) - Aug 26, 5 DAT E

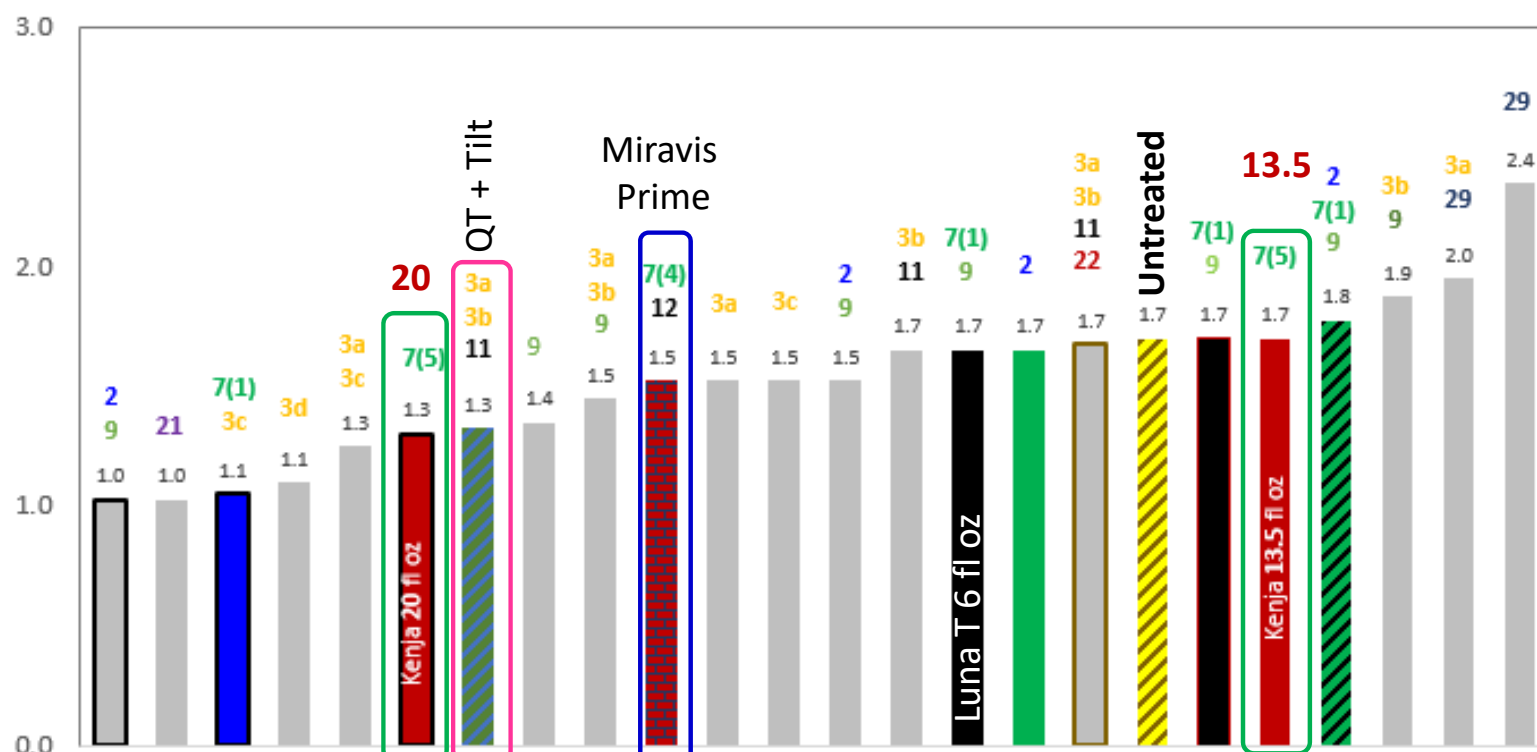
FRAC 7(5):

Kenja

- Low rate no different than untreated.
- High rate no different than QT + Tilt.

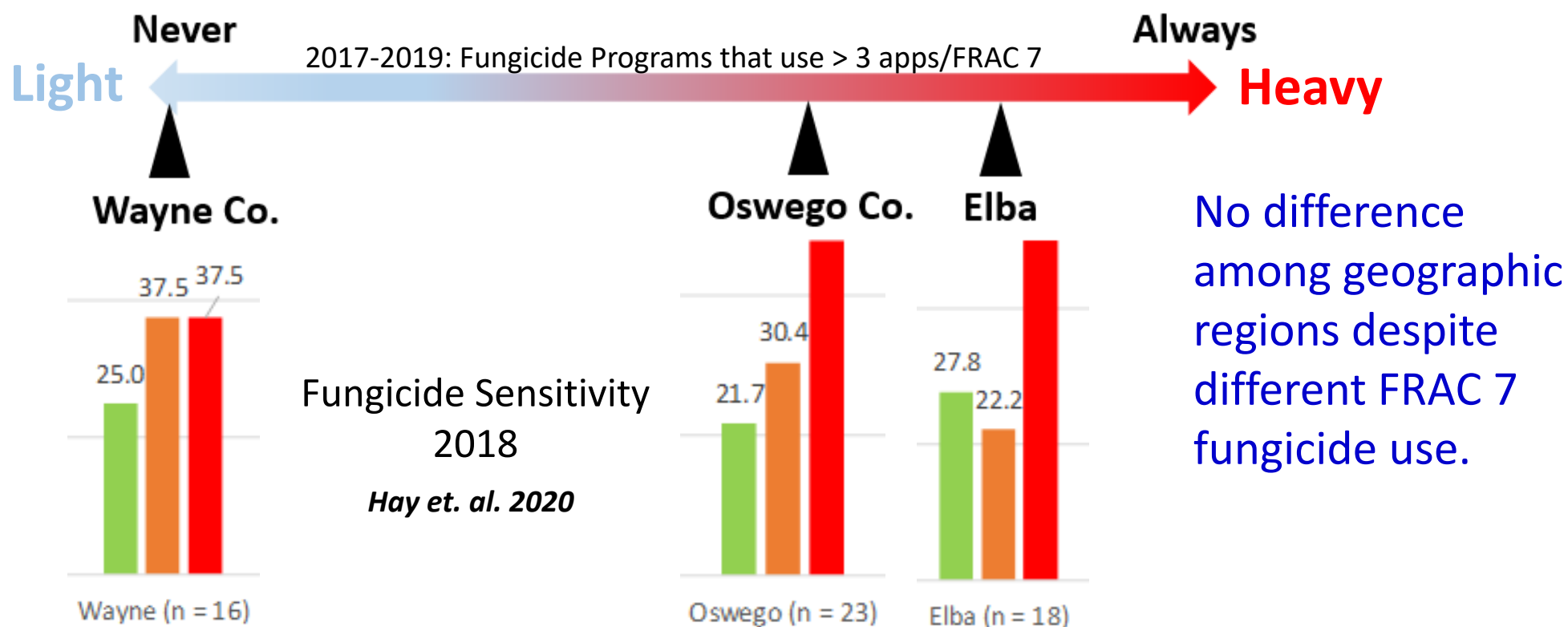
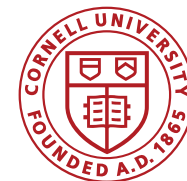
FRAC 7(4) + 12:

Miravis Prime

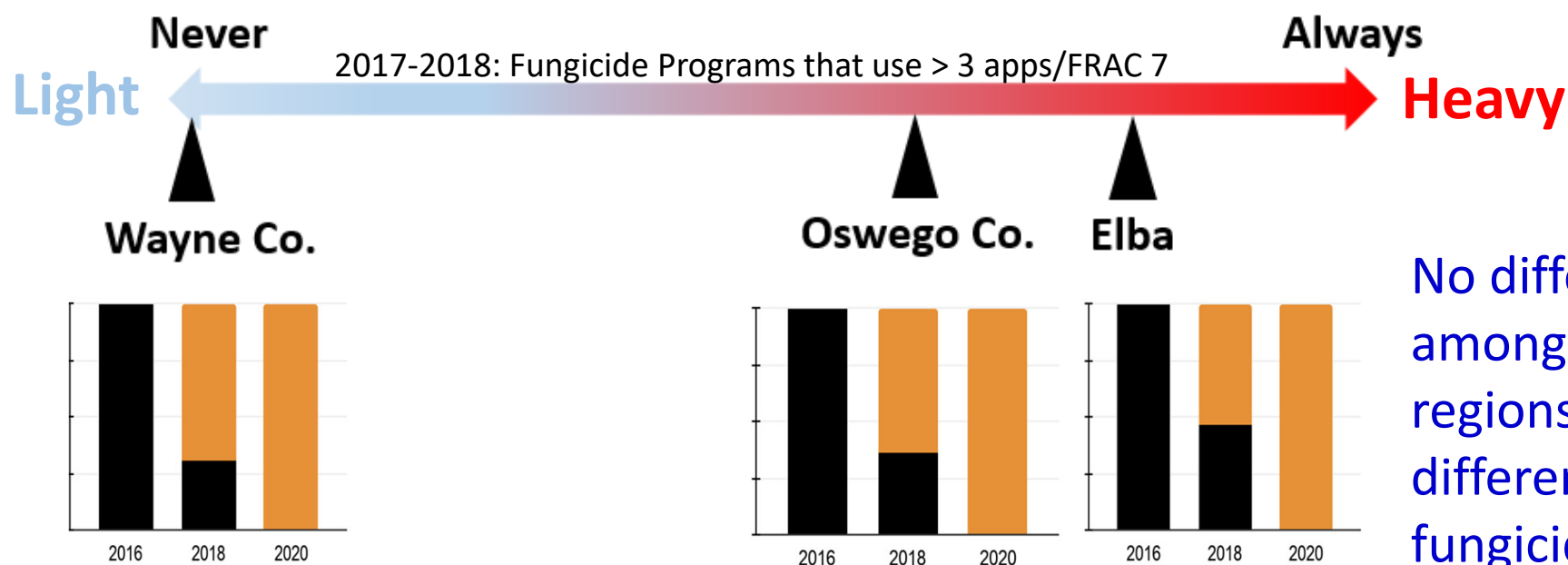
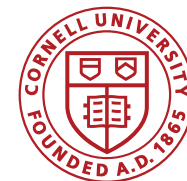


Hoepting et. al. 2020

Relationship Between Fungicide Use and Fungicide Resistance by Region



Relationship Between Fungicide Use and Fungicide Resistance By Region

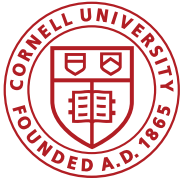


No difference among geographic regions despite different FRAC 7 fungicide use.

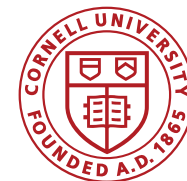
Presence of gene mutations in *sdh* genes
(% of isolates tested)

Heck et. al. 2020

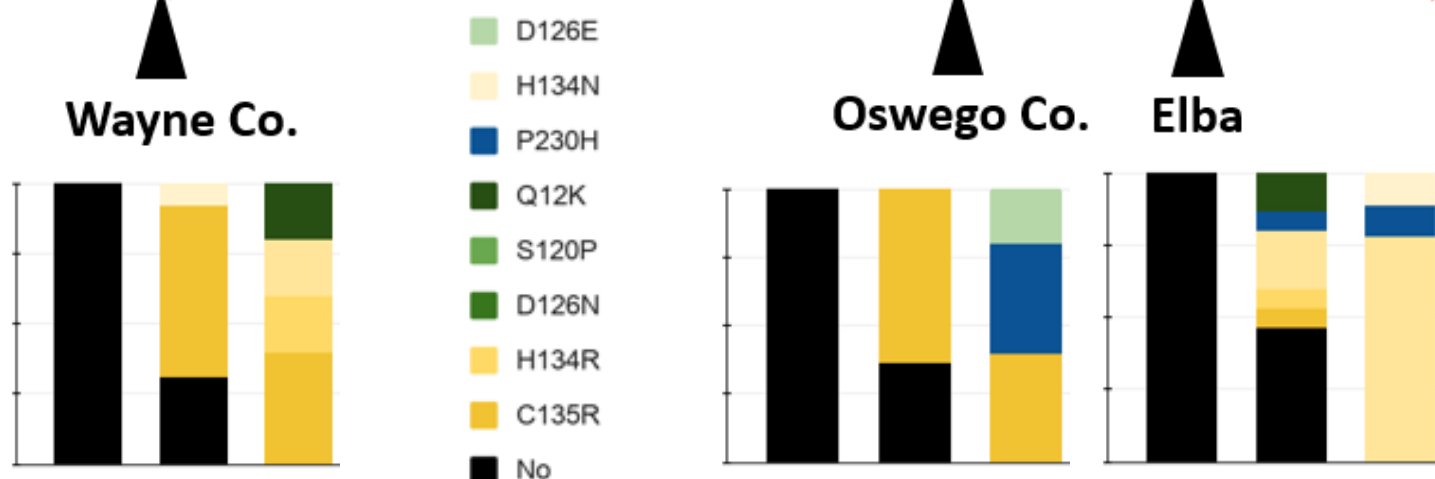
Is it over?



Relationship Between Fungicide Use and Fungicide Resistance By Region



Never ← 2017-2019: Fungicide Programs that use > 3 apps/FRAC 7 → Always
Light Heavy



Presence of gene mutations in *sdh* genes
(% of isolates tested)

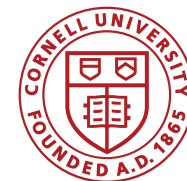
But there are differences in which *sdh* genes mutated among geographic regions.

- No *sdhB* (blue) gene mutations in Wayne.
- No *sdhD* (green) gene mutations in Oswego.

Heck et. al. 2020

2020 Oswego Early Fungicide Trial

% Green Foliage Sep 8 19 DAT J (10 sprays)



BLB/SLB Fungicide Trial, Oswego, NY, 2020 (c. v. Red Mountain):
% Green Foliage/Plot - 8 Sep, 19 DAT J (10 sprays)

BEST

FRAC 3b + 3a:

Quadris Top 14 fl oz
+ Tilt 8 fl oz

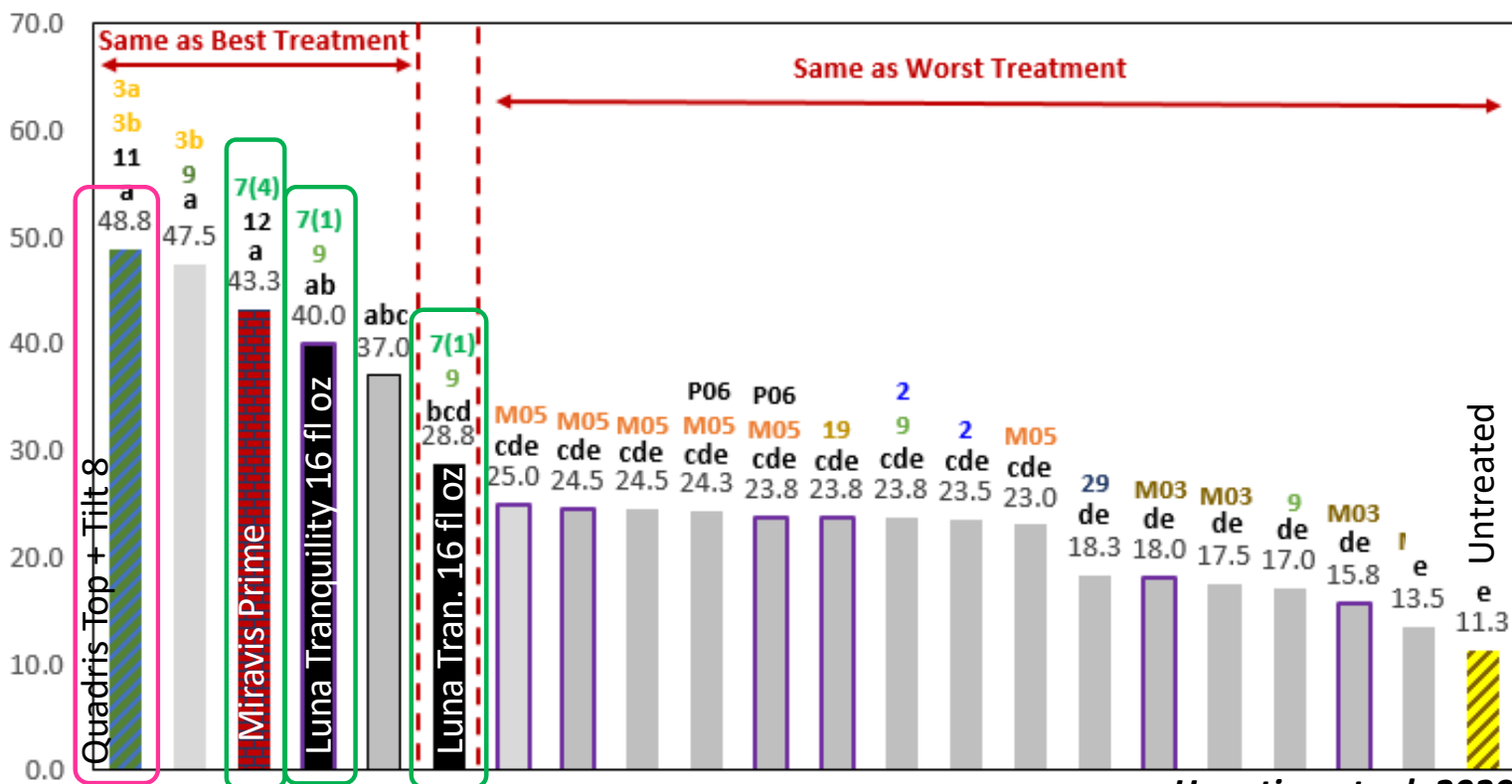
FRAC 7(1)

Luna Tranquility 16 fl oz
7(1) + 9a

FRAC 7(4)

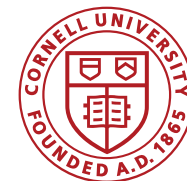
Miravis Prime 11.4 fl oz
7(4) + 12

As good as Qt + Tilt

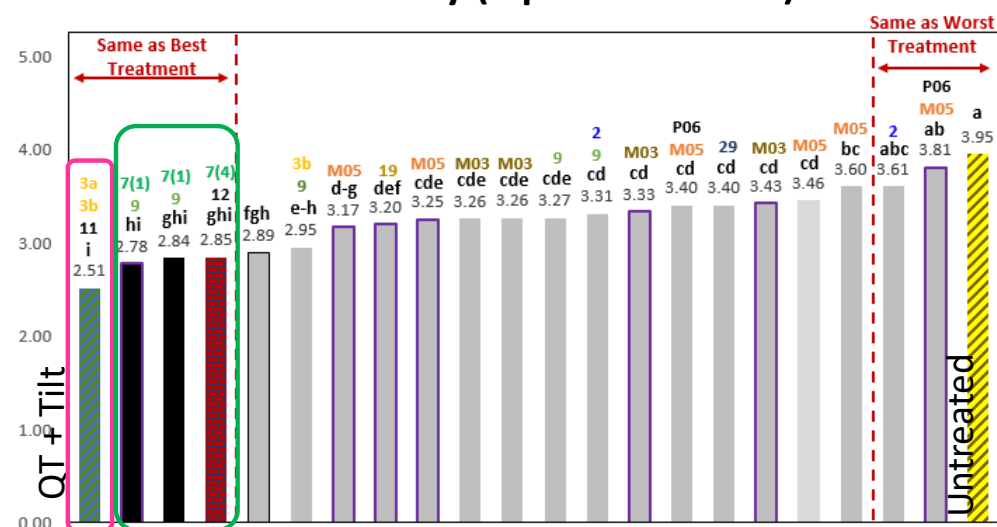


Hoepting et. al. 2020

2020 Oswego Early Fungicide Trial SLB Spores & Spots Sep 8 19 DAT J (10 sprays)



SLB Severity (Tip Colonization)



BEST

FRAC 3b + 3a:

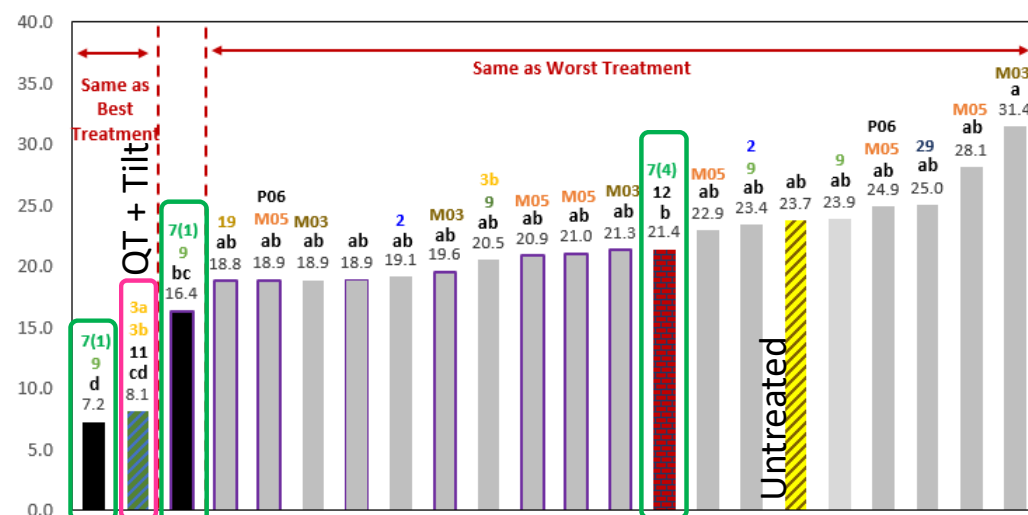
Quadris Top 14 fl oz + Tilt 8 fl oz

FRAC 7(1)

Luna Tranquility 16 fl oz

7(1) + 9a

No. Target Spots/plant



FRAC 7(4)

Miravis Prime 11.4 fl oz

7(4) + 12

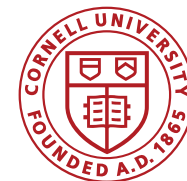
Appears that FRAC 7 subclasses 1 and 4 are still working on this farm in Oswego.

- May be regional differences.

Hoepting et. al. 2020

2020 Oswego Early Fungicide Trial

% Green Foliage Sep 8 19 DAT J (10 sprays)



48.8%



Quadris Top 14 fl oz
+ Tilt 8 fl oz
3b + 3a

43.3%



Miravis Prime
11.4 fl oz
7(4) + 12

40%



Luna Tranquility
16 fl oz
7(1) + 9b

28.8%



Luna Tranquility
16 fl oz
7(1) + 9b

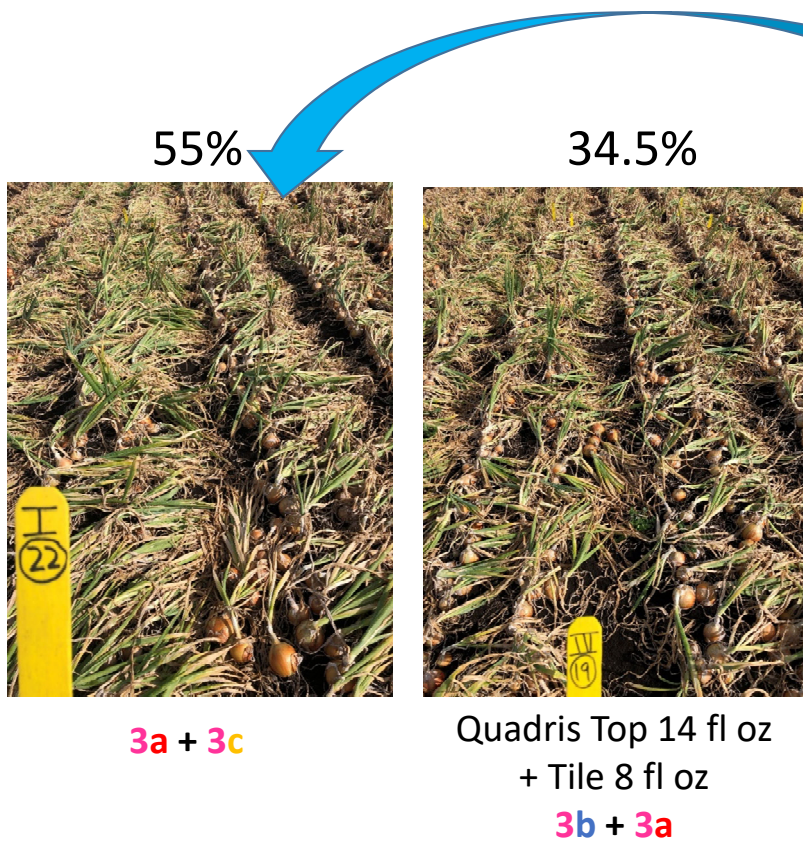
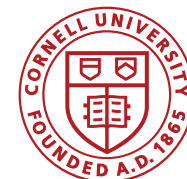
5.3%



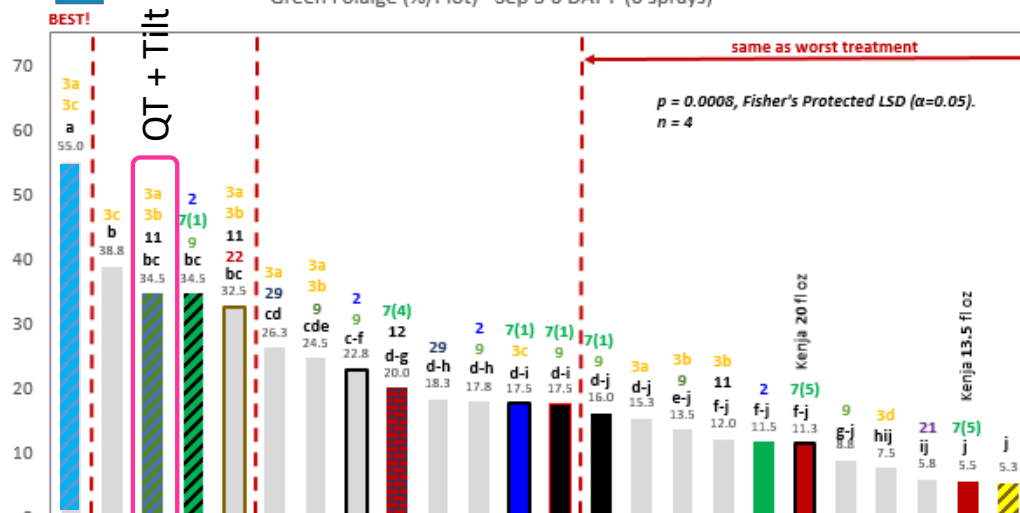
Untreated

2020 Elba Fungicide Product Trial

% Green Foliage Sep 3 6 DAT F (6 sprays)

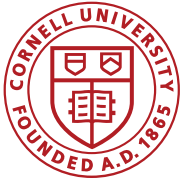


SLB Fungicide Trial, Elba, NY, 2020 (c.v. Hamilton):
Green Foliage (%/Plot) - Sep 3 6 DAT F (6 sprays)



Hoepting et. al. 2020

3a + 3c had significantly more green foliage than Quadris Top + Tilt



No Fungicide Recommendations Today – Next Steps

More results to come:

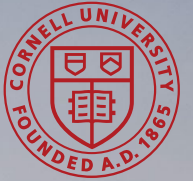
- Follow up gene mutation results with fungicide sensitivity testing to identify what the gene mutations mean
 - Insensitive vs, moderately sensitive
 - Cross-resistance among FRAC 7 sub-classes
- FRAC 3 fungicide sensitivity testing
- BLB fungicide trial results

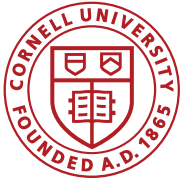
Wish list:

- Evaluate rate of SLB to develop fungicide resistance (SLB isolates collected from Elba trial)
 - Weekly application SLB fungicide
 - Co-application of SLB fungicides
 - Rotate SLB fungicide with biological or protectant fungicide
 - Bi-weekly applications of SLB fungicide
- FRAC 2 & 9 fungicide testing?
- FRAC 7 results by farm unlikely

Will be in touch with 2020 FINAL results and new fungicide recommendations – Stay tuned!

Onion Researchers in Training





Poll Question

In your opinion, what is the most effective strategy for managing fungicide resistance? (one answer)

1. Rotate FRAC groups
2. Co-apply FRAC groups
3. Reduce total number of apps per FRAC per crop
4. Use highest label rates
5. All of the above